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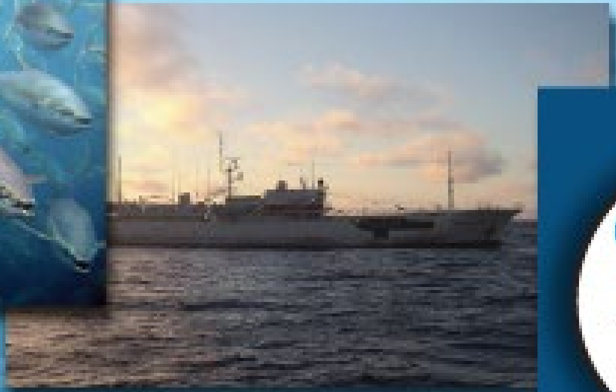

# METHODOLOGY FOR THE BEST SCIENTIFIC ESTIMATE (BSE) OF THE ANNUAL TOTAL NUMBER OF FLOATING-OBJECT SETS

(Appendices A-B of Document SAC-12-08)

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# Outline

- Background
- Overview of the Best Scientific Estimate (BSE) approach
- Some details of the BSE methodology
  - Set type classification algorithm
  - Evaluating the strength of evidence for misreporting
  - BSE formula for the number of floating-object (OBJ) sets

# Background

- There is concern that misreporting of set types may occur if the number of OBJ sets is used to define management measures.

- Therefore, a statistical approach has been developed to verify reported set types, and if necessary, adjust the total number of OBJ sets to correct for misreporting.

- The same general statistical approach can be used to verify the reported set type of sets made during an OBJ-set closure.

# Overview of the BSE approach

Data sources for the BSE

- Observer data
  - All Class-6 vessels;
  - Limited number of Class 1-5 vessels.
- Logbook data
  - Only to be used for trips of vessels that did not carry an observer.

# Overview of the BSE approach

BSE methodology

1) Build a set type classification algorithm with 2017-2019 data, using information on catch composition, operational characteristics and environmental factors.
2) Predict the set type of each set in the data to be screened.
3) Evaluate the evidence for misreporting of OBJ sets as either “dolphin” (DEL) or “unassociated” (NOA) sets.
4) Sum the number of OBJ sets, adjusting for misreported set types where applicable, to obtain the BSE.
5) Estimate an approximate 95% confidence interval for the BSE.

# Overview of the BSE approach

Use of the BSE

- Determine whether the *status quo* was maintained by comparing the average number of OBJ sets for 2017 -2019 to the confidence interval for the BSE.
- If the 2017-2019 average falls outside of the confidence interval, evaluate the control rule.

# Set type classification algorithm

- Random forests for classification (response variable: DEL/NOA/OBJ for Class-6; NOA/OBJ for Class 1-5).
- Method based on constructing a large number of classification trees, a "forest" (each built on a bootstrap data set).
- Predicted set type is based on the predictions of all the trees ("majority vote").
- Misclassification error is a forecast error.

  - Example of random forest algorithm, using observer data for Class-6 vessels.
  - Separate classification algorithm built for each year.
  - Algorithm performs well, especially for DEL and OBJ sets.
  - Error rates fairly stable from year to year.

Misclassification error (proportion sets misclassified)

| Year | DEL | NOA | OBJ |
|---|---|---|---|
| 2010 | 0.037 | 0.110 | 0.031 |
| 2011 | 0.020 | 0.091 | 0.039 |
| 2012 | 0.023 | 0.088 | 0.047 |
| 2013 | 0.022 | 0.115 | 0.048 |
| 2014 | 0.023 | 0.109 | 0.047 |
| 2015 | 0.022 | 0.109 | 0.056 |
| 2016 | 0.025 | 0.141 | 0.046 |
| 2017 | 0.020 | 0.116 | 0.047 |
| 2018 | 0.017 | 0.106 | 0.050 |
| 2019 | 0.011 | 0.065 | 0.040 |
| **Average** | **0.022** | **0.105** | **0.045** |

# Classification outcomes of interest

- To illustrate the classification outcomes of interest, an algorithm was built using observer data for Class-6 vessels, 2017-2019.

| | | Predicted set type | | | Misclassification Error |
|---|---|---|---|---|---|
| | | DEL | NOA | OBJ | |
| Reported set type | DEL | 27756 | 370 | 58 | 0.015 |
| | NOA | 879 | 13356 | 543 | 0.096 |
| | OBJ | 171 | 1335 | 31536 | 0.045 |

- $P_D$ and $P_N$ are the "baseline" (for Class-6).

| | | Predicted set type | | | |
|---|---|---|---|---|---|
| | | DEL | NOA | OBJ | |
| Reported set type | DEL | 98.48% | 1.31% | 0.21% | $P_D$ |
| | NOA | 5.95% | 90.38% | 3.7% | $P_N$ |
| | OBJ | 0.52% | 4.04% | 95.44% | |

- Interested in the difference between the $P_D$ and $P_N$ for 2017-2019 and the same quantities for the management year (*e.g.* 2021), $P^*_D$ and $P^*_N$:

$$\Delta_D = P^*_D - P_D \quad \text{and} \quad \Delta_N = P^*_N - P_N$$

- If $\Delta_D$ and $\Delta_N > 0$, they will be taken as the estimated percentage of misclassifications that in fact could be misreporting.

Note: $P_D$, $P^*_D$ and $\Delta_D$ only apply to Class-6.

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# Evaluating strength of evidence for misreporting

- Corrected set types will only be used when computing the BSE if there is strong evidence for misreporting.
- To evaluate the strength of evidence for misreporting, need to evaluate “natural” variability in $\Delta_D$ and $\Delta_N$.
- This will be done by conducting a simulation with 2010 – 2019 observer (logbook) data to determine how large $\Delta_D$ and $\Delta_N$ could be when set type misreporting is not expected.
- Use the simulation to generate distributions of the values of $\Delta_D$ and $\Delta_N$ , in the absence of misreporting.
- If the values of $\Delta_D$ or $\Delta_N$ for the management year (e.g. 2021) exceed the corresponding maximum values from the simulation, conclude that there is strong evidence for misreporting of OBJ as DEL and/or OBJ as NOA.

# BSE formula

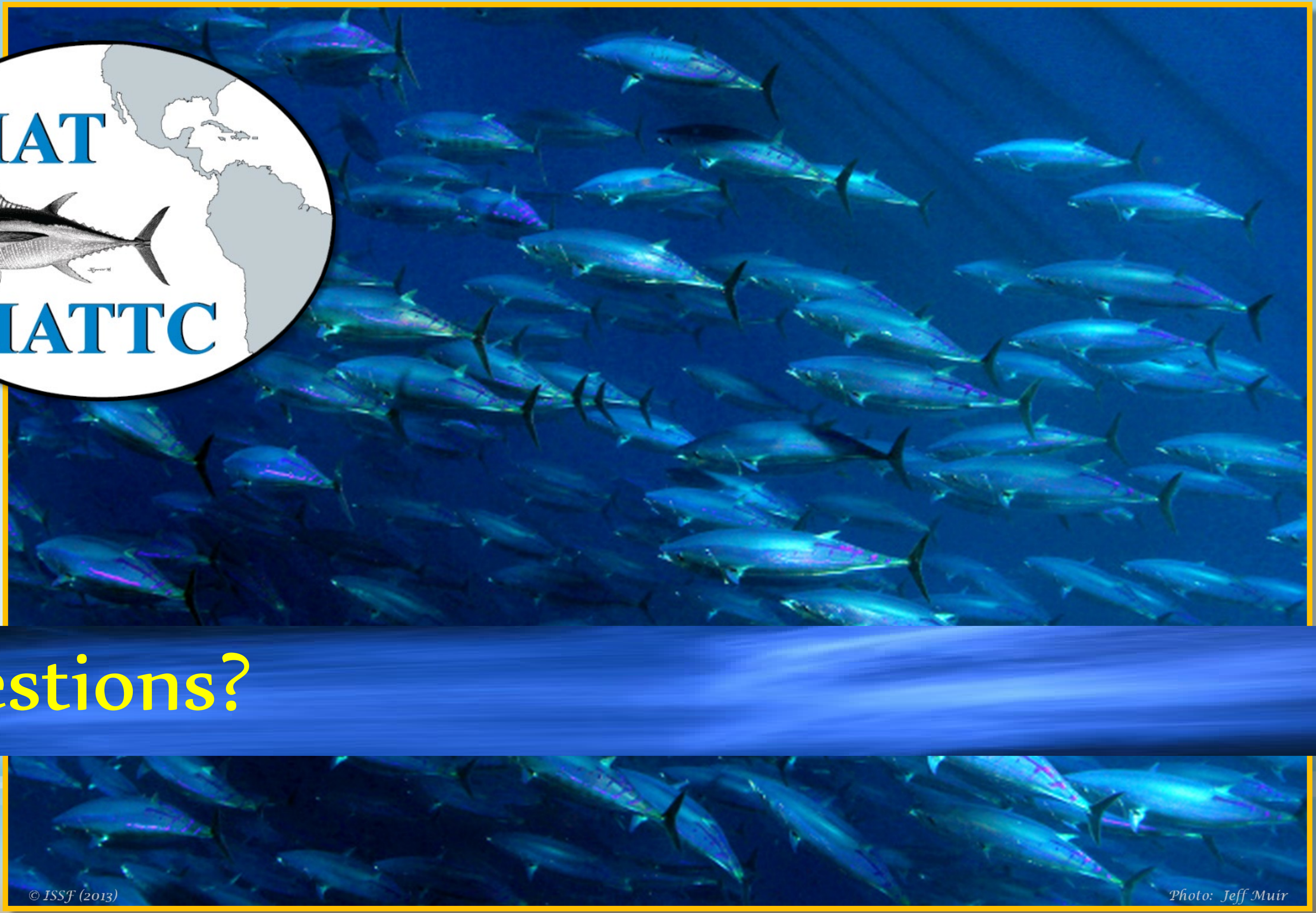
**BSE = number of OBJ sets reported by observers** +

*($\Delta_{D\_observer}$/100) x number of DEL sets reported by observers (if DEL misreporting found)* +

*($\Delta_{N\_observer}$/100) x number of NOA sets reported by observers (if NOA misreporting found)* +

**number of OBJ sets reported in logbooks (trips without observers)** +

*($\Delta_{N\_logbook}$/100) x number of NOA sets reported in logbooks (trips without observers; if NOA misreporting found)*




# Questions?